Space Weather Technical Forecast

Issued on Monday, 09 January 2023 at 01:06 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely, slight chance of X-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with four M-class flares observed in the past 24 hours, all originating from the newly numbered AR3184, which is emerging round the southeast limb. The largest were two M1.4 flares at 08/0948 UTC and 08/1507 UTC. A recent C9.7 flare observed at 08/1844 UTC originating from AR3184 produced a CME, which is currently being analysed, although given its location, this is unlikely to be Earth-Directed. There are currently five other numbered sunspot regions on the visible disc. AR3182 in the southeast remains the largest and most complex region on the visible disc, which is classified as a Eki/Beta-Gamma-Delta. This region has been responsible for most of the C class flares. AR3181 is the next largest. Its trailing penumbral area has developed a delta spot. AR3183 is smaller than these two regions and has simplified to a Beta/Csi. AR3180 and AR3177 both appear to be stable or decaying. No Earth-directed CMEs have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, have been slightly elevated throughout, with a peak of 468km/s at 08/0847 UTC, but generally averaging around 430km/s. Density was average or just below average. Total IMF, Bt, was weak at 7 nT or below. The north-south component, Bz, varied weakly between +5/-6 nT. Phi angle was predominately negative (towards the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2) throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2 MeV) has been at mostly background levels. The 24-hour integrated electron fluence was on a rising trend, but well below the Active threshold, reaching 4.32e6 integrated pfu at 09/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low to Moderate, with a slight chance of X-class flares through the forecast period, these most likely from AR3182 or AR3184 which is currently emerging around the southeast limb.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently expected. Solar wind speeds are slightly elevated at present, and are expected to continue to decline through Day 1 (09 Jan), probably to near background levels. The next feature of interest is CH62/-, with the HSS likely to arrive either at the end of Day 1 (09 Jan), or more likely on Day 2 (10 Jan). Geomagnetic activity is expected to be mostly Quiet at first, increasing with the HSS arrival either later on Day 1 or on Day 2 (09-10 Jan) to become Unsettled to Active, with a slight chance of a G1/Minor Storm. Activity then slowly declining through Day 3 and 4 (11-12 Jan).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux

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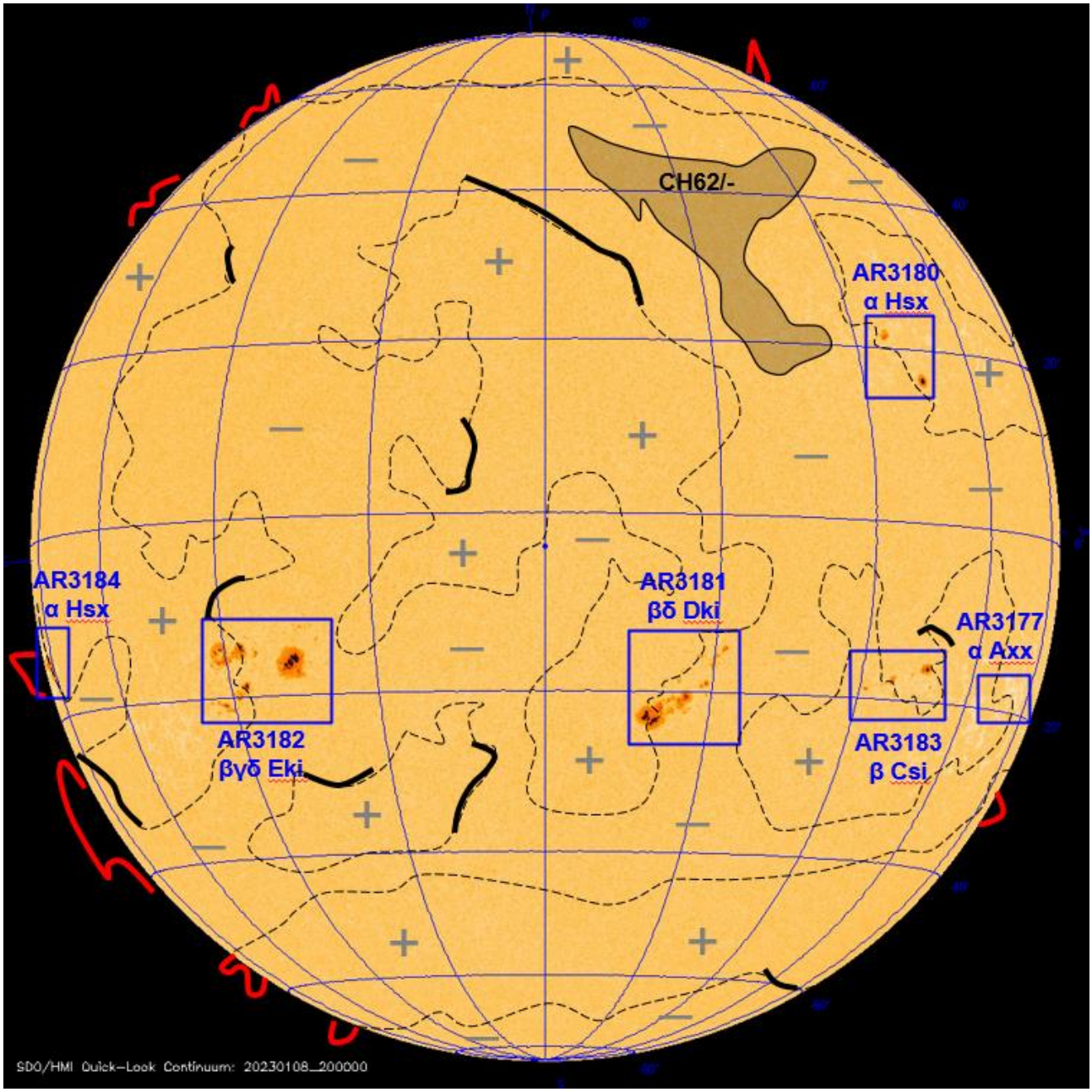
observed by GOES-16 is likely to remain at background levels throughout. However, there is a risk of an increase should any significant flares occur, giving a slight chance of exceeding the S1/Minor Storm threshold. Electron fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but possibly on a slight rising trend.

Figure 1. Solar Analysis Valid 08/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth directed CMEs are currently expected.

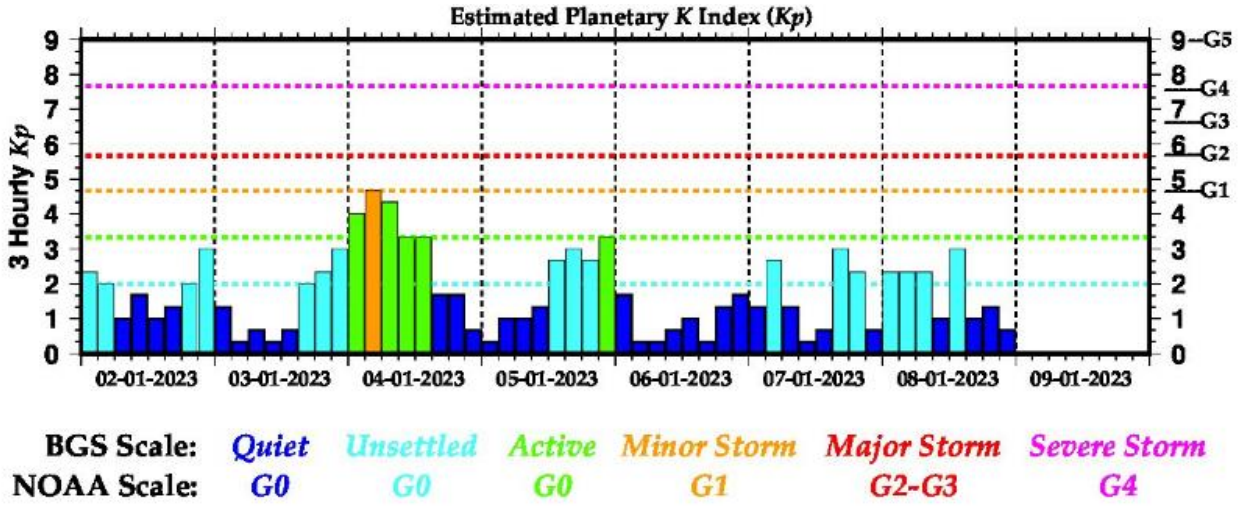
Solar wind speeds are slightly elevated at present, likely indicative of a waning HSS from either CH60 or CH61. Wind speeds are expected to continue to decline through Day 1 (09 Jan), probably to near background levels. This fits with STEREO-A data, which is now about a day upwind of Earth, and is showing a decline below 400 km/s. The next feature of interest is CH62/-,with the HSS likely to arrive either at the end of Day 1 (09 Jan), or more likely on Day 2 (10 Jan). This feature was faintly visible on the previous rotation but didn't produce a HSS. It is much more clearly visible this time around, suggesting it is more intense and therefore more likely to give an increase in wind speeds on this rotation. The timing of arrival had to be estimated from empirical techniques due to the lack of persistence data and it being too far ahead for STEREO to provide any useful data at this time.

Geomagnetic activity is expected to be mostly Quiet at first, increasing with the HSS arrival either later on Day 1 (09 Jan) or on Day 2 (10 Jan) to become Unsettled to Active, with a slight chance of a G1/Minor Storm. Activity then slowly declining through Day 3 and 4 (11-12 Jan).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil.

Figure 2: BGS estimated Kp.



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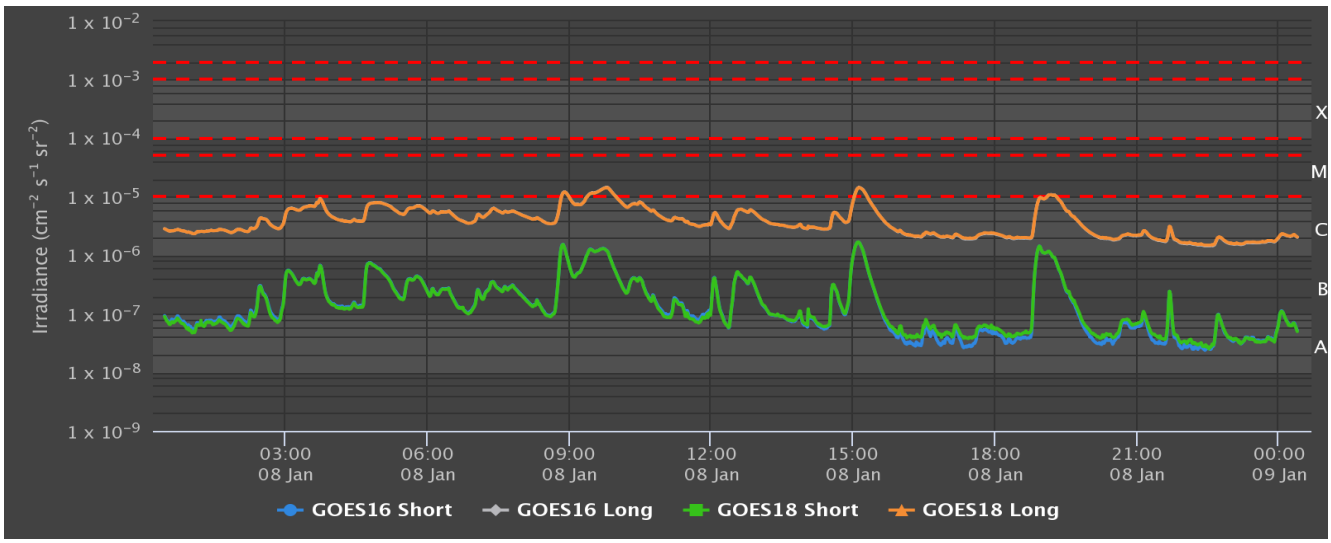
Radio Blackouts - X-Ray Flares:
There are currently six numbered sunspot regions on the visible. AR3182 (Eki/Beta-Gamma-Delta) remains the largest and most magnetically complex region on the disc. There appears to be a couple of small delta spots in the trailing area. AR3181 (Dki/Beta-Delta) showed some growth over the last 24 hours, with a delta spot emerging within the trailing penumbra. AR3183 (Csi/Beta) is much smaller than the other two areas mentioned, and has simplified its magnetic complexity. AR3180 in the north has been stable and AR3177 is continuing to decay. However, attention turns to the SE limb, where newly numbered AR3184 has been emerging during the last 12 hours. This has already produced four M-class flares from around the SE limb, with a recent C9 flare producing a CME, which is currently being analysed, although unlikely to be Earth-directed, given its location. A better analysis of AR3184 will be conducted once it moves around from the SE limb onto the visible disc.

Solar activity has been Moderate over the past 24 hours, with the newly numbered AR3184 on the SE limb producing all the recent M-class flares (as mentioned above). Solar activity is likely to be mainly Low to Moderate with a slight chance of X-class flares. There is the potential for further regions to rotate around from the east limb. Recent EUVI imagery does show some bright flux just around the east limb (probably associated with AR3184), and far side seismographs are indicating plenty of activity on the far side.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: GOES X-Ray flares – shows M class flares originating from newly numbered AR3184 on the SE limb.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 is currently at background levels.

However, any significant flares will bring a risk of proton flux rising, with a slight chance of exceeding the S1/Minor Storm threshold. This risk increases slightly through the period, due mainly to the risk presented by AR3182 as it rotates further westwards across the disc, towards a position where it is more likely to connect with Earth for proton storm events.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at largely background levels. Electron flux levels may start to rise in the coming days, but this is expected to be modest, perhaps reaching Moderate levels at the diurnal peaks. The onset of the next HSS from CH62 either later on Day 1 or more likely during Day 2 (09-10 Jan) is expected to cause a further suppression of flux levels. This HSS is expected to be stronger than on previous rotation, but any electron response is more likely to occur after the end of this four day period.
Electron fluence is therefore expected to remain below the Active (1e8 integrated pfu) threshold, perhaps on a slight rising trend. MOSWOC REFM is currently forecasting well below Active, which is considered good guidance. Confidence in fluence remaining below Active is reasonable, but lower for the timing of any increase especially towards the end of the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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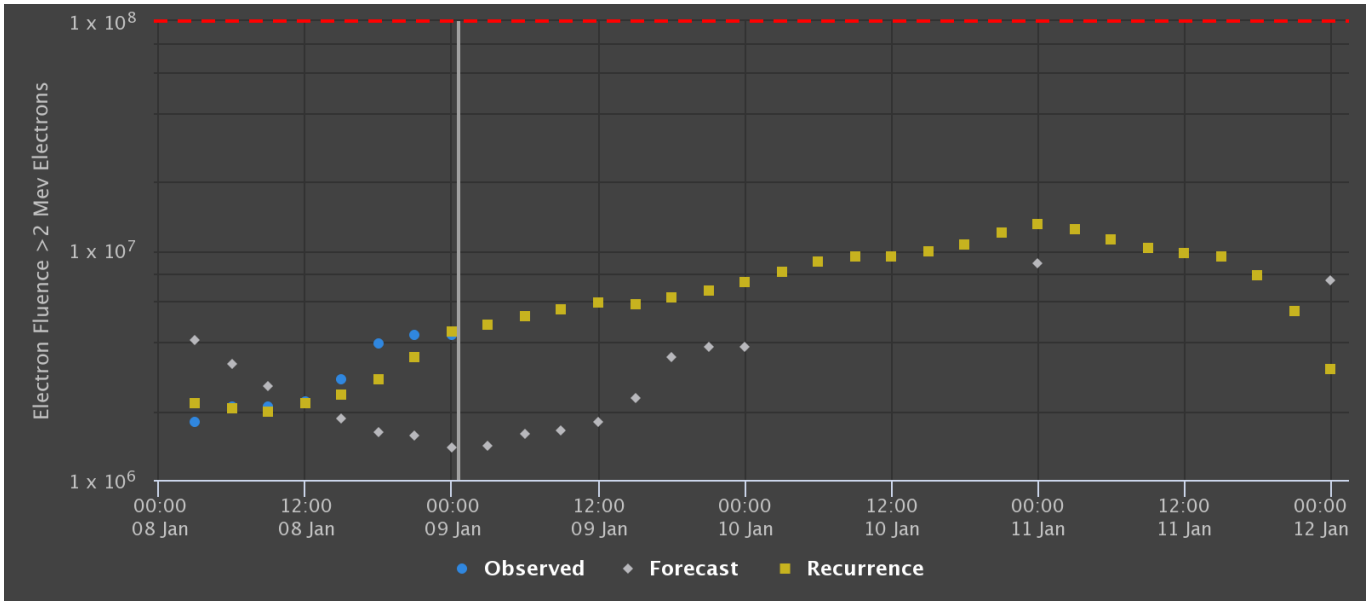
Figure 4: MOSWOC REFM and observations



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